Android builders summit
The Android media framework

Author: Bert Van Dam & Poornachandra Kallare
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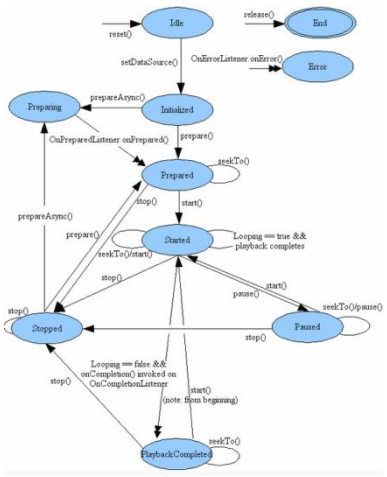
Usage models

- Use the framework: MediaPlayer
  - android.media.MediaPlayer
  - Framework manages
    - Demuxing
    - Decoding
    - AV synchronization
    - AV rendering



- DIY: the application manages
  - Demuxing: android.media.mediaExtractor
  - Decoding: android.media.MediaCodec
  - Video rendering: android.media.MediaCodec
  - Audio rendering: android.media.AudioTrack

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MediaPlayer usage model

- The easy way: instantiate VideoView
  - Creates the MediaPlayer for you
  - Exports similar API to MediaPlayer

- The slightly more complicated way
  - Application creates SurfaceView
  - Application creates MediaPlayer
  - MediaPlayer.setSurface(surface)

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Which media players exist

- Built-in players
  - AwesomePlayer (default player selected)
  - NuPlayer (Apple HLS)
  - SonivoxPlayer (midi files)
  - testPlayer
- Extra player factories can be registered
- Every player provides same interface
  - frameworks/av/include/media/MediaPlayerInterface.h

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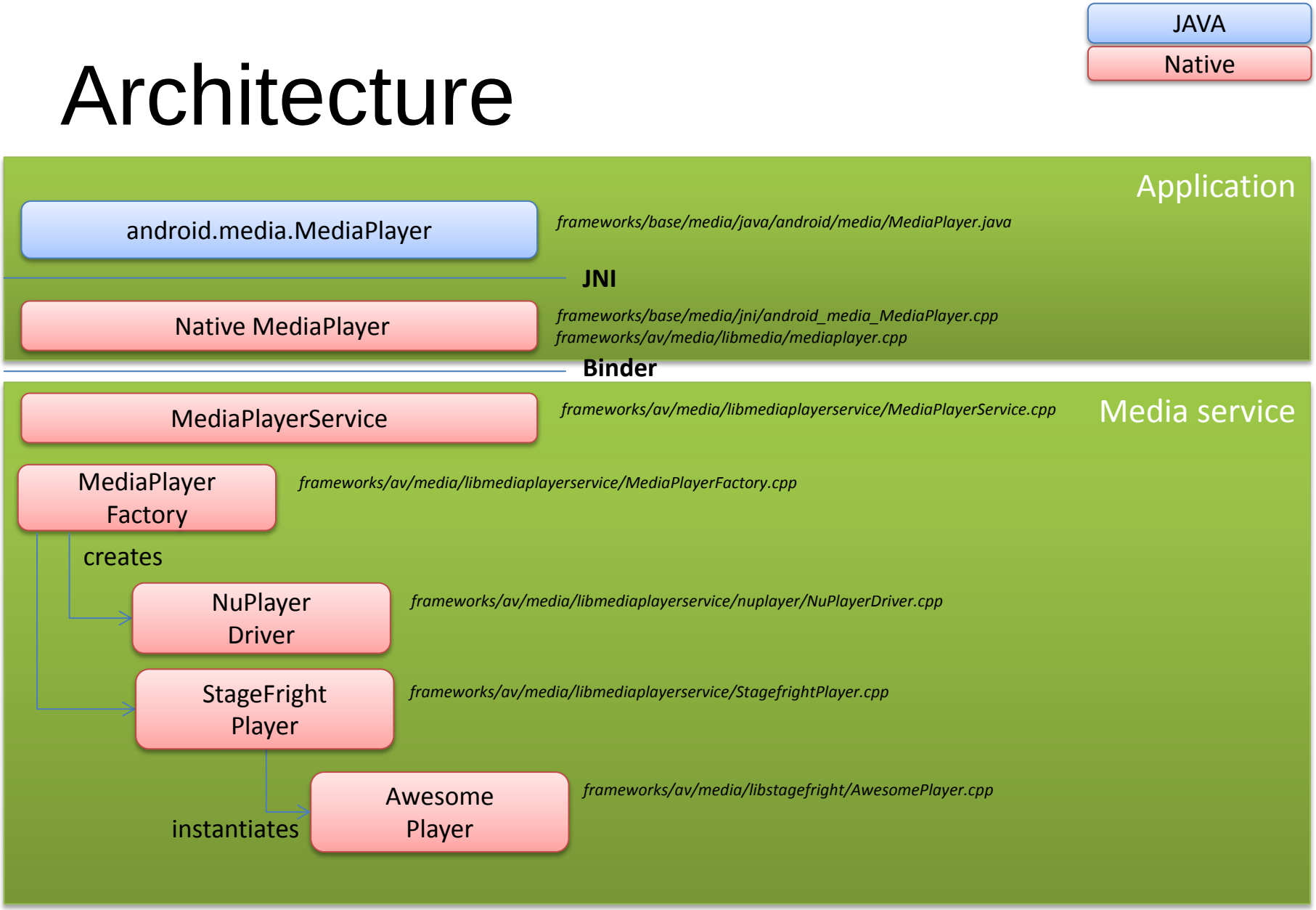
Architecture



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Player creation (simplified)

JAVA

Native

(1) mp = new MediaPlayer();

Application

native_setup(**new WeakReference<MediaPlayer>(this));**

MediaPlayer.java

sp<MediaPlayer> mp = **new MediaPlayer();**

android_media_MediaPlayer.cpp

Object initialization
mAudioSessionId = AudioSystem::newAudioSessionId();
AudioSystem::acquireAudioSessionId(mAudioSessionId);

mediaplayer.cpp

Nothing much happened yet …

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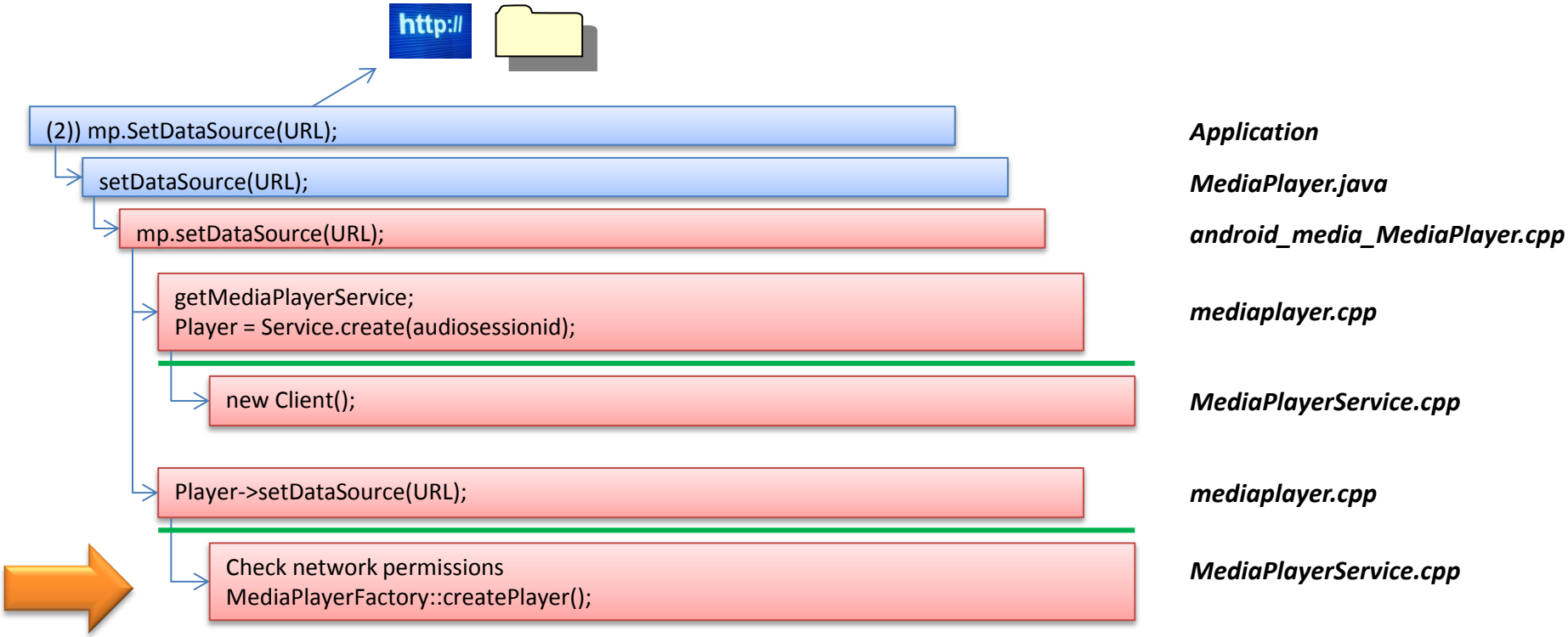
Player creation (simplified)

JAVA
Native
binder



Which player handles this URL???

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Player creation factory

Default is StageFright

```
player_type MediaPlayerFactory::getDefaultPlayerType() {
   char value[PROPERTY_VALUE_MAX];
   if (property_get("media.stagefright.use-nuplayer", value, NULL)
         && (!strcmp("1", value) || !strcasecmp("true", value))) {
      return NU_PLAYER;
   }

   return STAGEFRIGHT_PLAYER;
}
```

Handle these extensions only

```
class SonivoxPlayerFactory : public
MediaPlayerFactory::IFactory {
 public:
   virtual float scoreFactory(const sp<IMediaPlayer>& client,
                              const char* url,
                              float curScore) {
      static const float kOurScore = 0.4;
      static const char* const FILE_EXTS[] = { ".mid",
                                               ".midi",
                                               ".smf",
                                               ".xmf",
                                               ".mxmf",
                                               ".imy",
                                               ".rtttl",
                                               ".rtx",
                                               ".ota" };
```

Apple HLS

And RTSP

```
class NuPlayerFactory : public MediaPlayerFactory::IFactory
{
 public:
   virtual float scoreFactory(const sp<IMediaPlayer>& client,
                              const char* url,
                              float curScore) {
      static const float kOurScore = 0.8;

      if (kOurScore <= curScore)
         return 0.0;

      if (!strncasecmp("http://", url, 7)
            || !strncasecmp("https://", url, 8)) {
         size_t len = strlen(url);
         if (len >= 5 && !strcasecmp(".m3u8", &url[len - 5])) {
            return kOurScore;
         }

         if (strstr(url,"m3u8")) {
            return kOurScore;
         }
      }

      if (!strncasecmp("rtsp://", url, 7)) {
         return kOurScore;
      }

      return 0.0;
   }
```

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AwesomePlayer

- Building blocks
  - OMX-IL
    - http://www.khronos.org/openmax/il/
    - Standardized interface for accessing streaming components
    - Google provides set of SW decoders
    - SOC suppliers provide HW accelerated decoders
  - MediaExtractors
    - *frameworks/av/media/libstagefright/*
    - Classes capable of demuxing specific container formats (MP3Extractor, MPEG4Extractor, MatroskaExtractor, …)
    - Allow extraction of audio, video, subtitle tracks
  - Audioflinger, surfaceflinger for rendering

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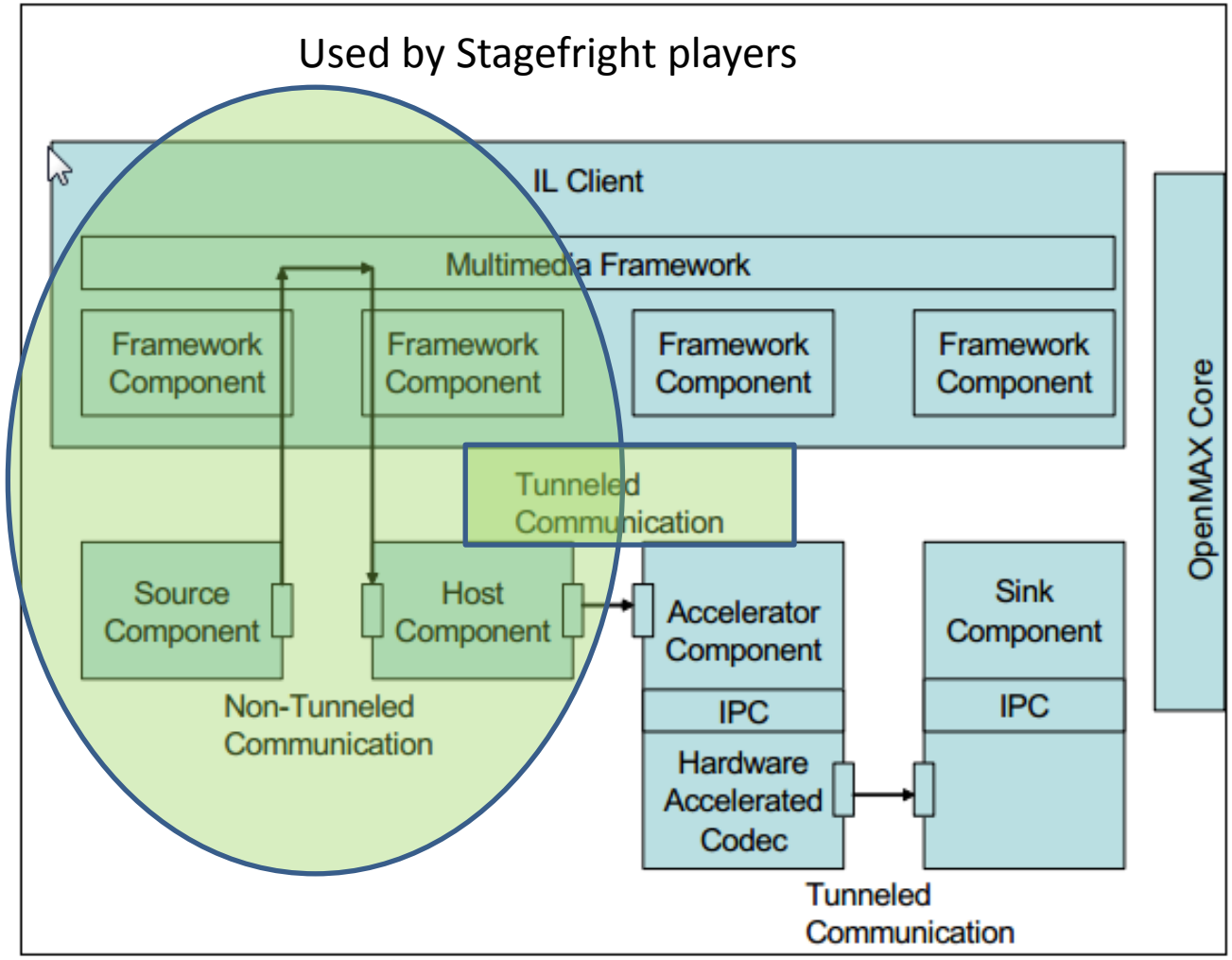
OMX-IL - principles



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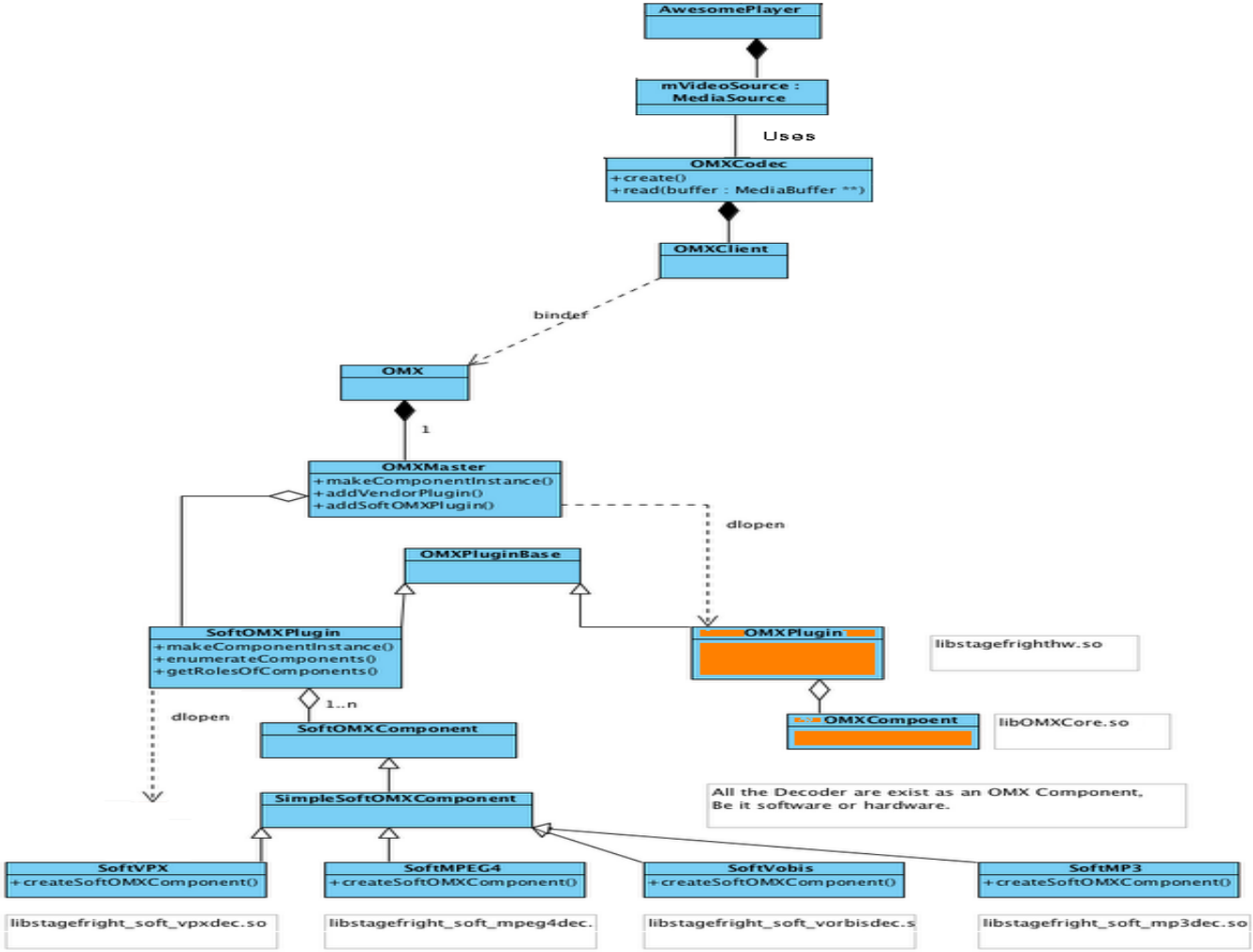
OMX-IL – Android integration



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OMX-IL – example config file

media_codecs.xml

```xml
<MediaCodecs>
    <Decoders>
        <MediaCodec name="OMX.google.mp3.decoder" type="audio/mpeg" />
        <MediaCodec name="OMX.google.amrnb.decoder" type="audio/3gpp" />
        <MediaCodec name="OMX.google.amrwb.decoder" type="audio/amr-wb" />
        <MediaCodec name="OMX.google.aac.decoder" type="audio/mp4a-latm" />
        <MediaCodec name="OMX.google.g711.alaw.decoder" type="audio/g711-alaw" />
        <MediaCodec name="OMX.google.g711.mlaw.decoder" type="audio/g711-mlaw" />
        <MediaCodec name="OMX.google.vorbis.decoder" type="audio/vorbis" />

        <MediaCodec name="OMX.google.mpeg4.decoder" type="video/mp4v-es" />
        <MediaCodec name="OMX.google.h263.decoder" type="video/3gpp" />
        <MediaCodec name="OMX.google.h264.decoder" type="video/avc" />
        <MediaCodec name="OMX.google.vpx.decoder" type="video/x-vnd.on2.vp8" />
    </Decoders>

    <Encoders>
        <MediaCodec name="OMX.google.aac.encoder" type="audio/mp4a-latm" />
        <MediaCodec name="OMX.google.amrnb.encoder" type="audio/3gpp" />
        <MediaCodec name="OMX.google.amrwb.encoder" type="audio/amr-wb" />
        <MediaCodec name="OMX.google.h263.encoder" type="video/3gpp" />
        <MediaCodec name="OMX.google.h264.encoder" type="video/avc" />
        <MediaCodec name="OMX.google.mpeg4.encoder" type="video/mp4v-es" />
        <MediaCodec name="OMX.google.flac.encoder" type="audio/flac" />
    </Encoders>
</MediaCodecs>
```

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MediaPlayer.prepare

Example 

AwesomePlayer.cpp

mConnectingDataSource = HTTPBase::Create;	**creates a ChromiumHttpClient**
mConnectingDataSource->connect(URL);	
mCachedSource = new NuCachedSource2();	
dataSource = mCachedSource;	**Go through the cache from here onwards**

AwesomePlayer.cpp

Wait for 192 KB of data in the cache	
Datasource->sniff() ;	**Detect the MIME type of the stream**
extractor = MediaExtractor::Create(MIME, datasource);	**Create the extractor**
Calculate bitrate of stream through extractor	
Select first video and audio stream as default	
initVideoDecoder()	**Create and start the video decoder**
mVideoSource = OMXCodec::Create();	
mVideoSource->start();	
initAudioDecoder();	**Create and start the audio decoder**
mAudioSource = OMXCodec::Create();	
mAudioSource->start();	
Continue buffering	**Notify Prepared state when highwatermark is reached**

Already registered

```
RegisterSniffer_l(SniffMPEG4);
RegisterSniffer_l(SniffMatroska);
RegisterSniffer_l(SniffOgg);
RegisterSniffer_l(SniffWAV);
RegisterSniffer_l(SniffFLAC);
RegisterSniffer_l(SniffAMR);
RegisterSniffer_l(SniffMPEG2TS);
RegisterSniffer_l(SniffMP3);
RegisterSniffer_l(SniffAAC);
RegisterSniffer_l(SniffMPEG2PS);
RegisterSniffer_l(SniffWVM);
```

MediaPlayer is now ready to start playback
Decoding is not yet happening at this stage!!!

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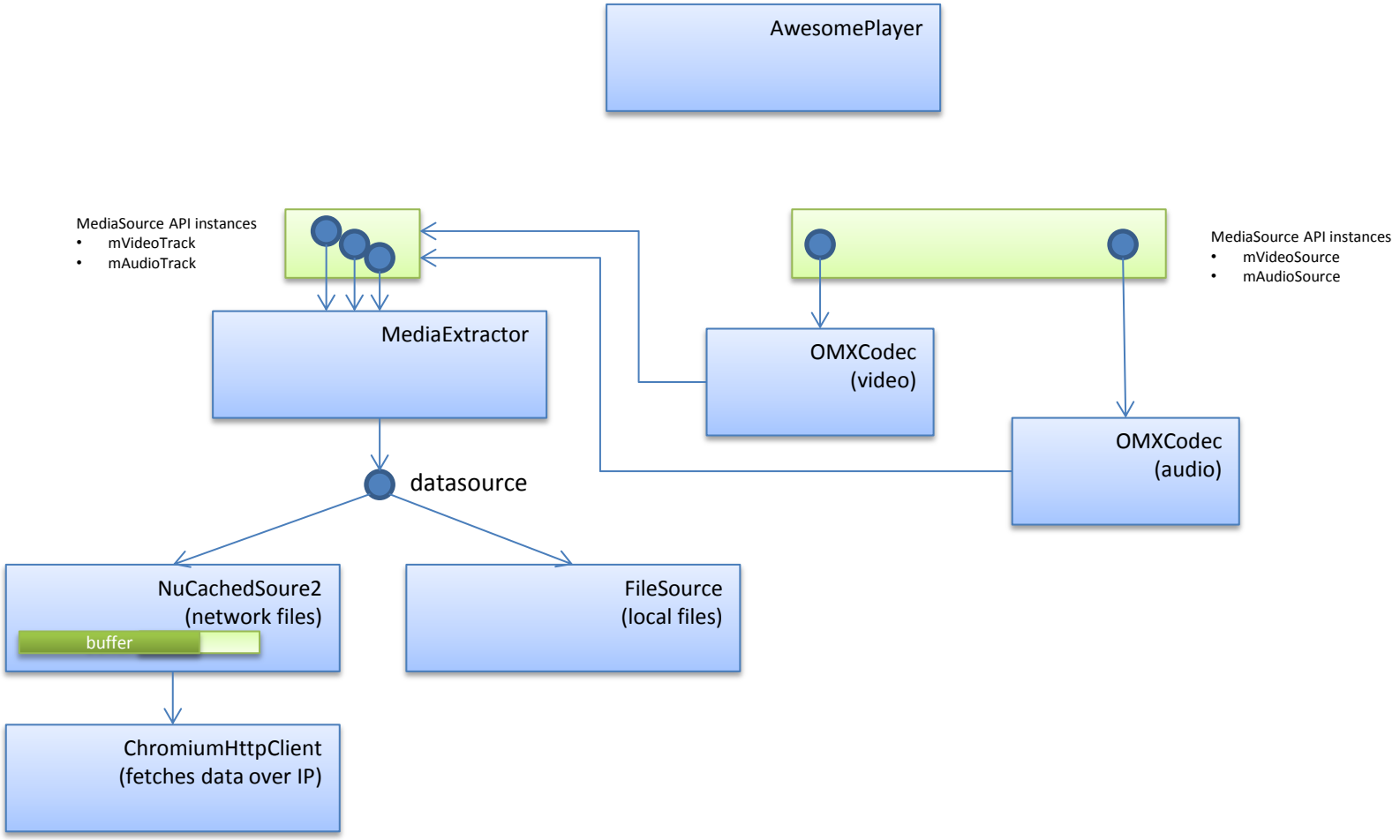
Status after prepare



MediaPlayer.start

Application

mp.setSurface();	Call needed to have a destination for rendering (VideoView srf)
mp.start();	

AwesomePlayer.cpp

mAudioPlayer = **new AudioPlayer();**	
mAudioPlayer->setSource(mAudioSource);	
mTimeSource = mAudioPlayer;	Audio track used as timing reference
startAudioPlayer_l();	Starts the audio player
mTextDriver->start();	Start subtitle player
initRenderer_l();	Initialize the rendering path (based on SW/HW codec)
Start video event generation	loop of video events with A/V sync logic
Render buffers after applying AV sync logic	

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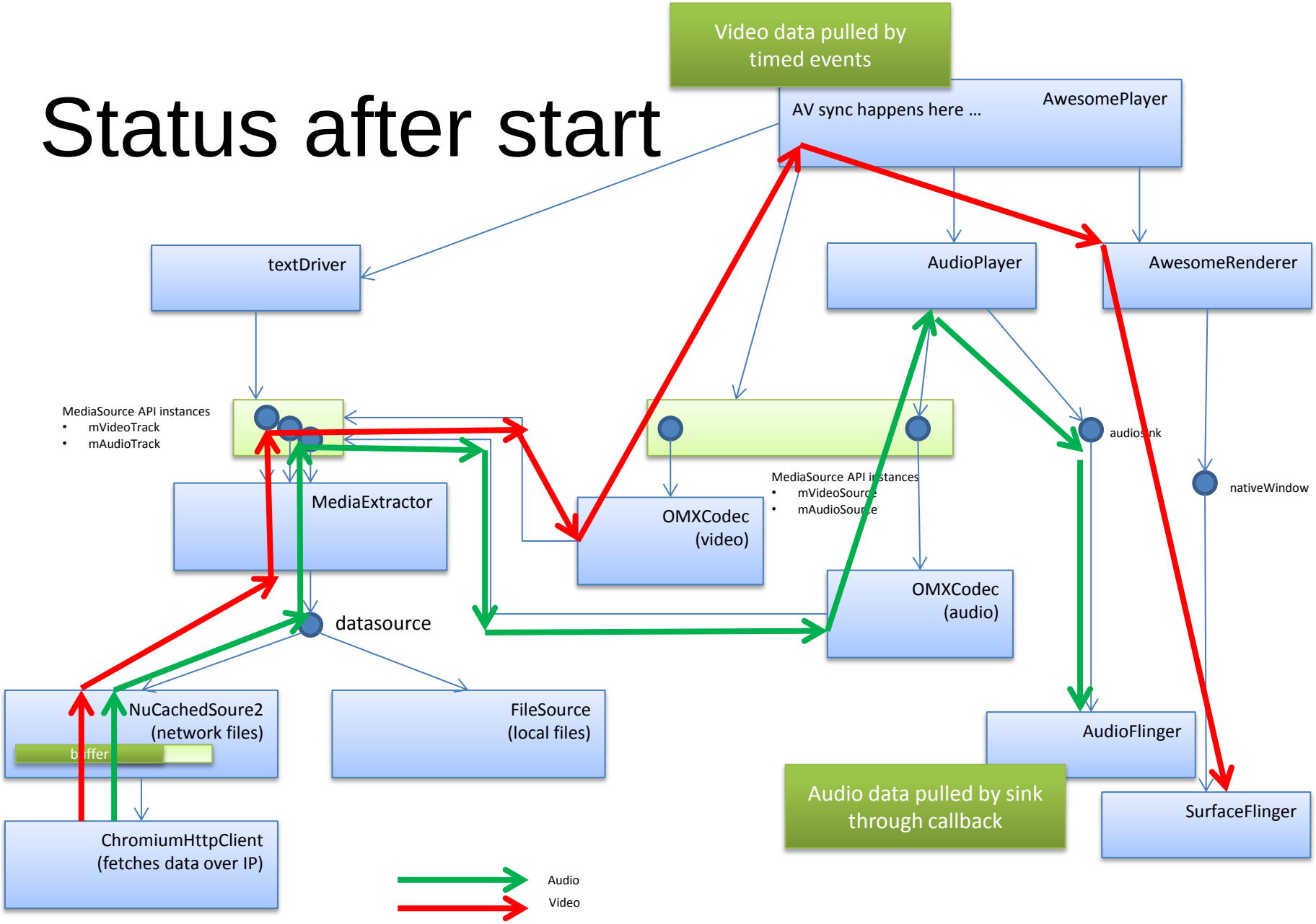
Status after start



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Track selection

– MediaPlayer. getTrackInfo
  - Returns list of tracks

Constants	
int	MEDIA_TRACK_TYPE_AUDIO
int	MEDIA_TRACK_TYPE_TIMEDTEXT
int	MEDIA_TRACK_TYPE_UNKNOWN
int	MEDIA_TRACK_TYPE_VIDEO

– MediaPlayer. selectTrack(idx)
  - Maps to MediaExtractor
  - Select audio, video or subtitle track

Subtitle handling

- Limited formats supported
  - SRT, 3GPP
- Both embedded and external files
  - addTimedTextSource to add external file
  - MediaPlayer.getTrackInfo returns both internal and external subtitle tracks
- Player takes care of syncing to playback time
  - TimedText notifications raised at correct time

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Subtitle rendering

To render the timed text, applications need to do the following:

- Implement the `MediaPlayer.OnTimedTextListener` interface
- Register the `MediaPlayer.OnTimedTextListener` callback on a MediaPlayer object that is used for playback
- When a onTimedText callback is received, do the following:
  - call `getText()` to get the characters for rendering
  - call `getBounds()` to get the text rendering area/region

Simple TextView can be used to render

The DIY model

- android.media.MediaCodecList
  - Returns supported formats
  - Based on config.xml file explained before
- android.media.MediaCodec
  - Is basically an abstraction of OMX-IL
  - Application juggles buffers to and from component
- Application acts as the player in this case
  - Responsible for rendering + AV sync

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The DIY model – typical setup

MyActivity

```
Create SurfaceView (for rendering video)
Create AudioTrack (for rendering audio)
Create MediaExtractor (alternatively have your own system for ES retrieval)
    -> query tracks
    -> selectTrack(audio track idx)
    -> selectTrack(video track idx)
    -> getTrackFormat(idx)
Create MediaCodec for audio and for video
Configure MediaCodecs as per formats detected above, and start them

while (1) on thread 1
{
  extr.readSampleData
  extr.getSampleTrackIndex                    // determine if it's the audio or video
  extr.getSampleTime                          // presentation time
  audio/videodec.queueInputBuffer
}
~~~
while(1) on thread 2
{
  audio/videodec.dequeueOutputBuffer
  audiotrack.write  for audio – videodec.releaseOutputBuffer for video
}
```

MediaExtractor

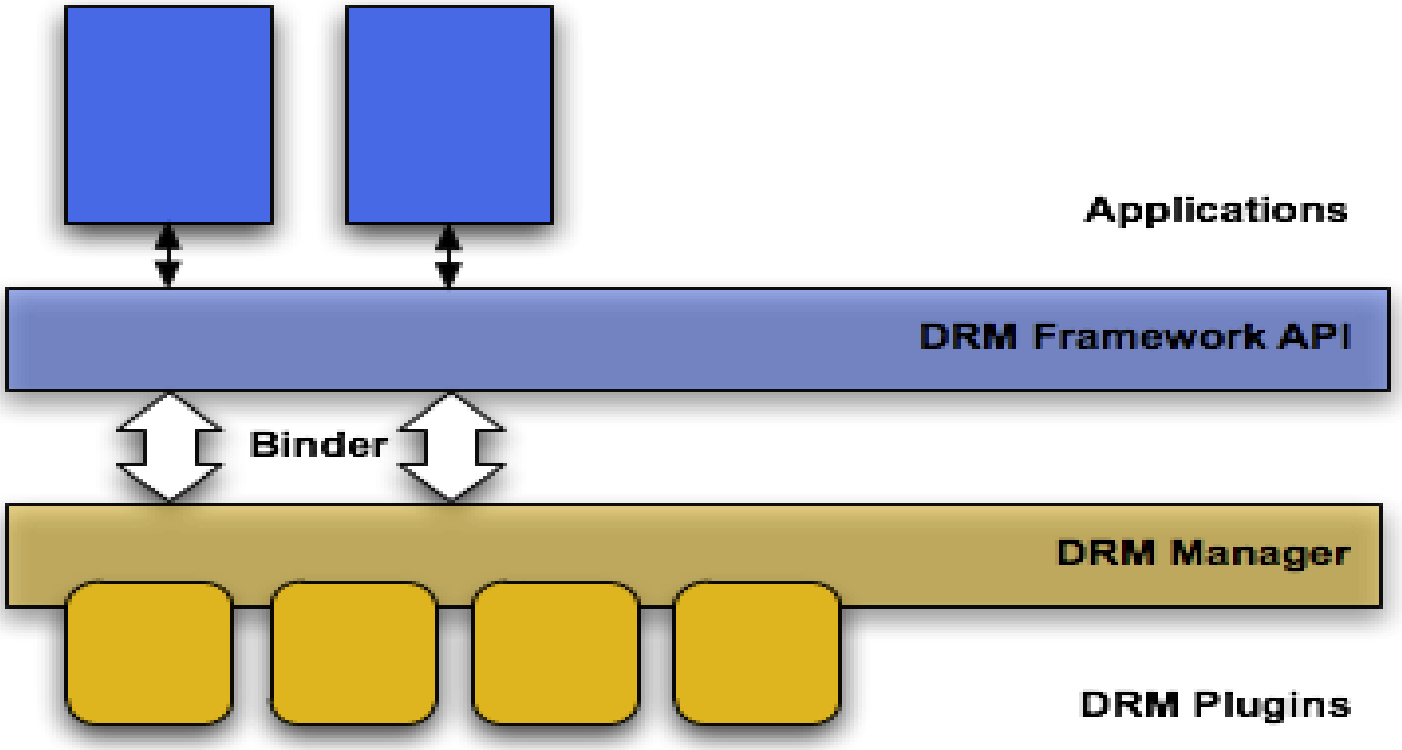
SurfaceView

MediaCodec audiodec

MediaCodec videodec

AudioTrack

Classic DRM Framework



http://developer.android.com/reference/android/drm/package-summary.html

Classic DRM Framework

- The Android DRM framework is implemented in two architectural layers
  - A DRM framework API exposed to applications via Dalvik/Java.
    - Application/DRM specific handling for license acquisition, etc.
  - A native code DRM manager
    - Implements the DRM framework
    - Exposes an interface for DRM plugins (agents) to handle rights management and decryption for various DRM schemes.

- The interface for plugin developers is listed and documented in DrmEngineBase.h.
  - Identical to the Java DRM Framework API (DrmManagerClient).

- On the device, the DRM plugins are located in “/vendor/lib/drm” or in “/system/lib/drm”.

- DRM Plugins work with media framework for content decryption

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Prepare Redux – Classic DRM

Example

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mAudioSource->start();	
Continue buffering	**Notify Prepared state when highwatermark is reached**

Already registered

RegisterSniffer(SniffDRM)

There is a media extractor instance for DRM called DrmExtractor. DrmExtractor implements SniffDRM

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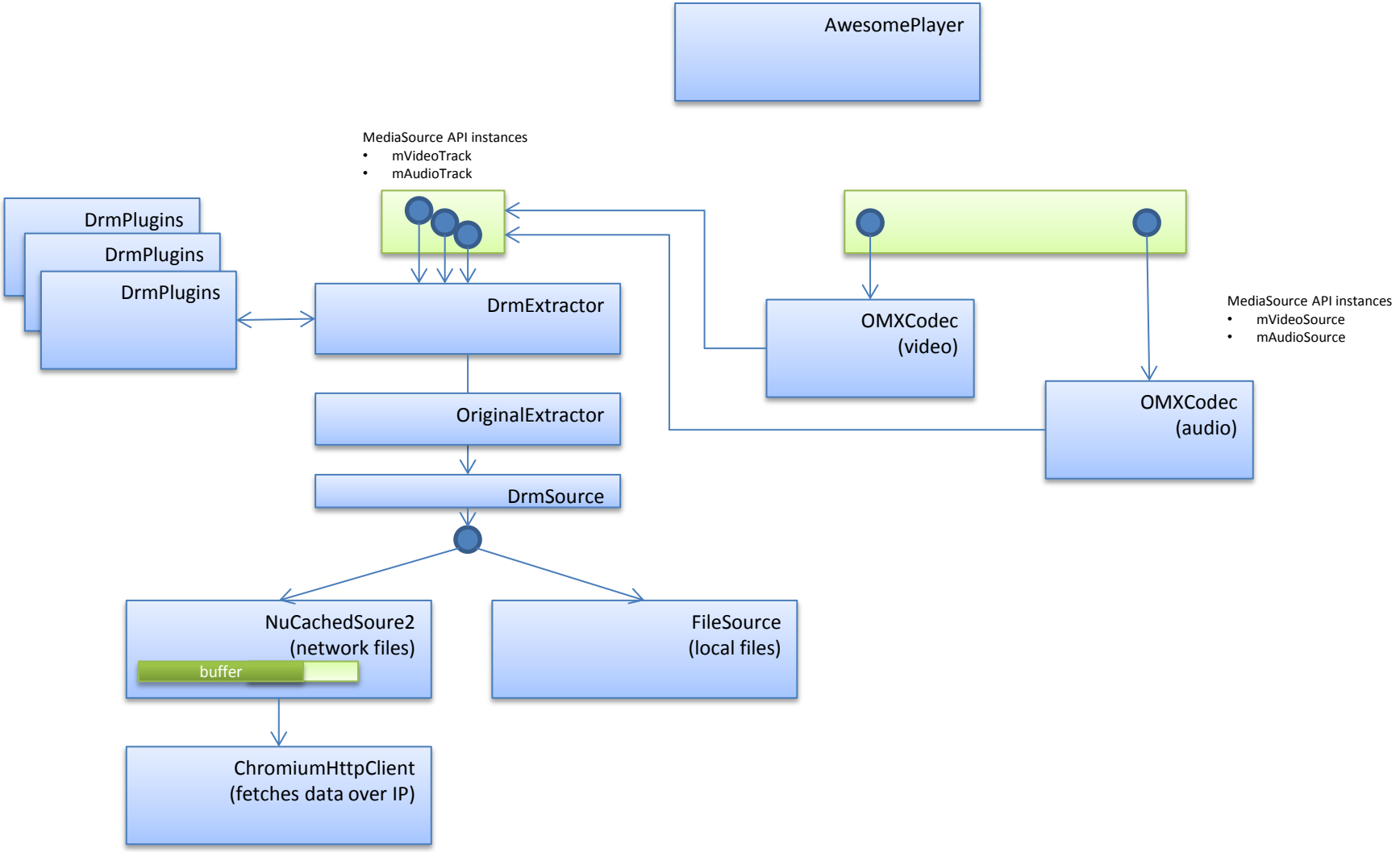
Status after prepare – Classic DRM



DRM with media codec

- Applications using mediacodec can also use DRM
  - Example: MPEG DASH CENC
  - Using MediaCrypto and MediaDRM
- MediaDRM provides application API to
  - Provision DRM clients
  - Generate DRM/content specific challenges
  - Download licenses/keys
  - Generate a session ID that can be used to create media crypto objects
- MediaCrypto object obtained from MediaDRM can then be used with mediacodec
  - Submit to media codec using

    public final void queueSecureInputBuffer (int index, int offset, MediaCodec.CryptoInfo info, long presentationTimeUs, int flags)
- Internally uses a plugin framework
  - Not the same plugins as used in classic DRM !
  - Different set of plugins with different API

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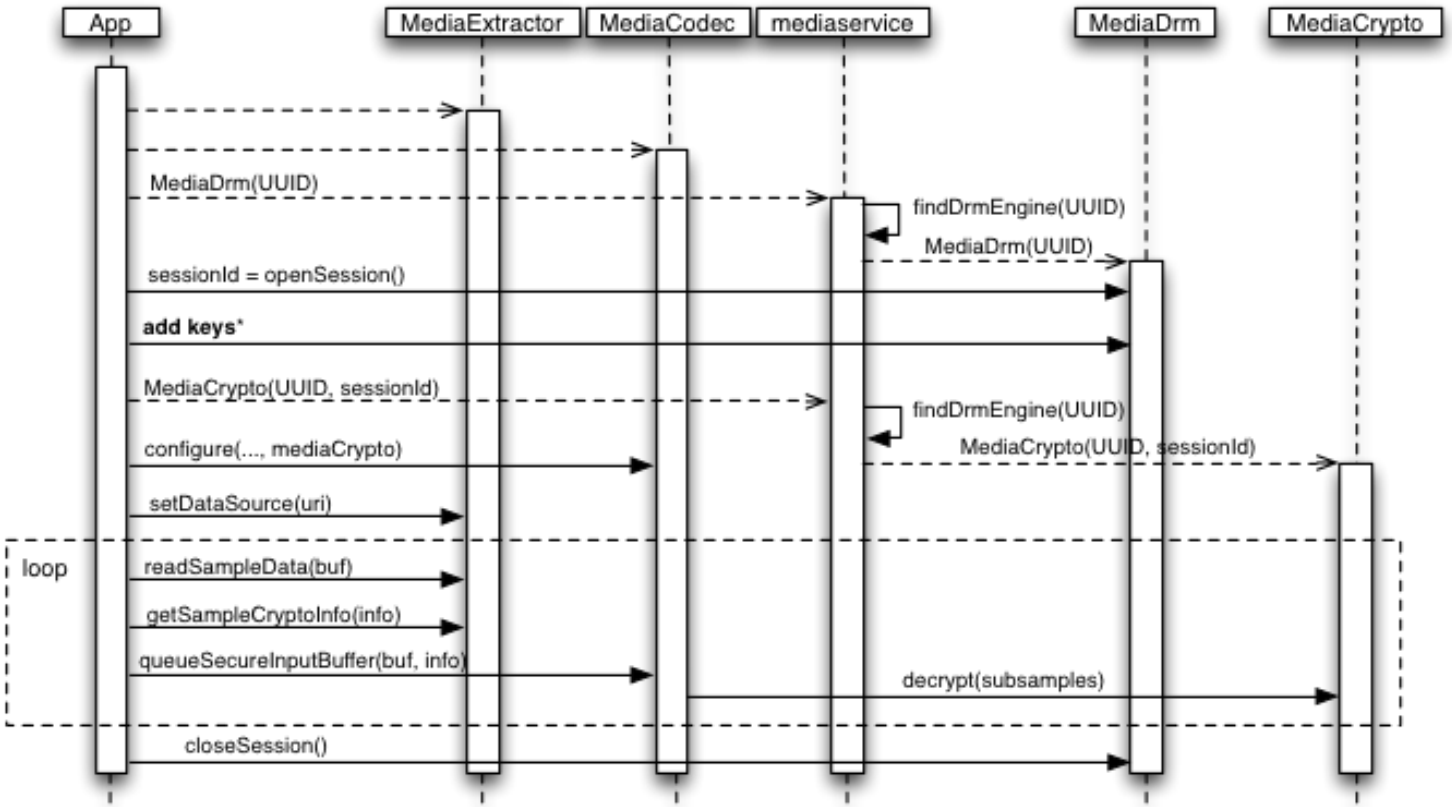
DRM with Mediacodec



***add keys**:
getKeyRequest(), keySetId = provideKeyResponse()
OR if resuming an offline session, use restoreKeys(keySetId)

http://developer.android.com/reference/android/media/MediaDrm.html

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Media framework changes

- Audio track selection improvements
  - Improve runtime audio track changes
- Trickmodes
  - Android only supports Seek
  - I-Frame based trickmodes, DLNA compliancy (x1/2, x1/4)
- Adaptive streaming added (DASH, …)
- Subtitle gaps
  - Add SAMI, SUB, external TTML, …
- DRM extensions
  - PlayReady, WMDRM, Marlin

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TV inputs

Extra player taking care of TV inputs (tuner, extensions)

```
class TvPlayerFactory :public MediaPlayerFactory::IFactory {
 public:
    virtual float scoreFactory(const sp<IMediaPlayer>& client,
                               const char* url,
                               float curScore)
    {
        static const float kOurScore = 2.0;

        if (kOurScore <= curScore)
            return 0.0;

        if (!strncasecmp("tv://", url, 5))
        {
            return kOurScore;
        }
        return 0.0;
    }

    virtual sp<MediaPlayerBase> createPlayer() {
        ALOGV(" create TvPlayerBase");
        return new TvPlayerBase();
    }
};
```

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